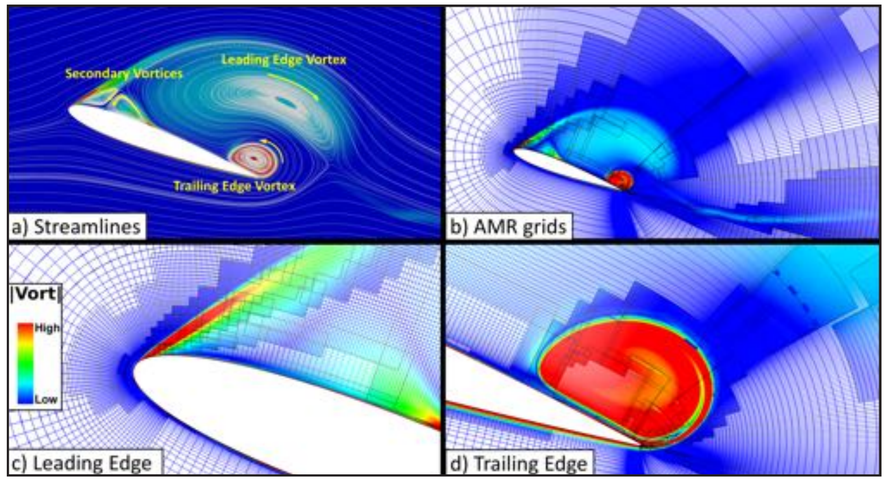
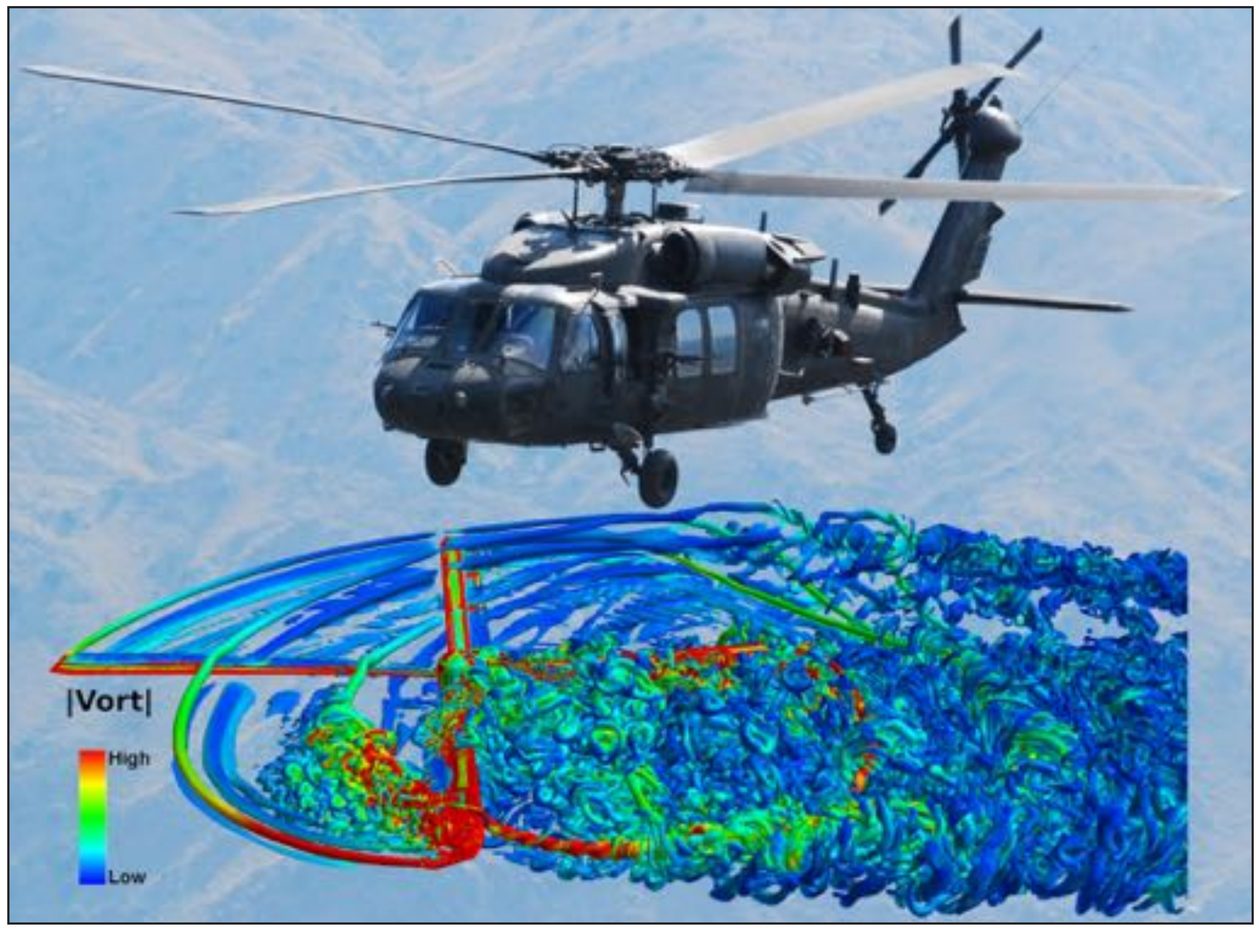
National Aeronautics and
Space Administration



This image shows (a) the airflow (streamlines) about an airfoil oscillating between 0 – 20 degrees angle of attack. Dynamic stall occurs when the airflow separates from the airfoil, causing sudden loss in lift, increase in drag, and nose-down pitching moment. Adaptive mesh refinement (b, c, d), improves the simulation accuracy by automatically refining the computational mesh in regions where the flow is rapidly changing. Red corresponds to high vorticity and blue to low vorticity. *Neal M. Chaderjian, NASA/Ames*



Top: A Blackhawk helicopter in forward flight. Bottom: CFD simulation of the Blackhawk rotor undergoing dynamic stall. The rotor wake and blade-tip vortices are visualized with isosurfaces of the Q-criterion, colored by vorticity magnitude (red is high, blue is low). This is the first time blade-vortex interaction has been shown to cause dynamic stall (bright red area in lower part of image). AMR is used to refine the mesh near the flexible rotor blade surface and establish a grid-converged solution. *Neal M. Chaderjian, NASA/Ames*

Advanced CFD Tools for Accurate Rotorcraft Analysis and Design

Imagine trying to build a new home without power tools! The goal of this research is to develop advanced computational fluid dynamics (CFD) "power tools" that enable discovery of complex flow physics and facilitate the analysis and design of new rotorcraft concepts at a reduced computational cost.

We use adaptive mesh refinement (AMR) to better resolve a rotor's vortex wake by automatically adding finer Cartesian meshes in regions where the flow changes rapidly. This is more efficient than refining the mesh throughout the entire computational domain. For the first time, AMR is being used to better resolve complex separated flow by automatically adding finer curvilinear meshes on flexible rotor blades. This provides rotorcraft engineers with a powerful new analysis and design tool.

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